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Module 8: Energy Forms

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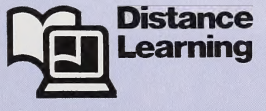
Science 24

Module 8

ENERGY IN ACTION



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Science 24
Student Module
Module 8
Energy in Action
Alberta Distance Learning Centre
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Welcome to Module 8!

We hope you'll enjoy your study of Energy in Action.

To make your learning a bit easier, a teacher will help guide you through the material.

So whenever you see this icon,

turn on your audiocassette and listen.

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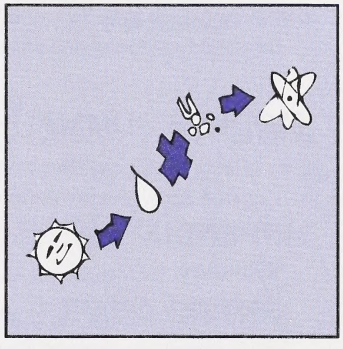

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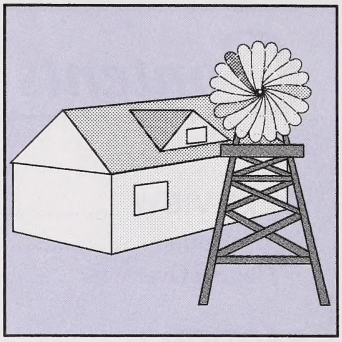


OVERVIEW

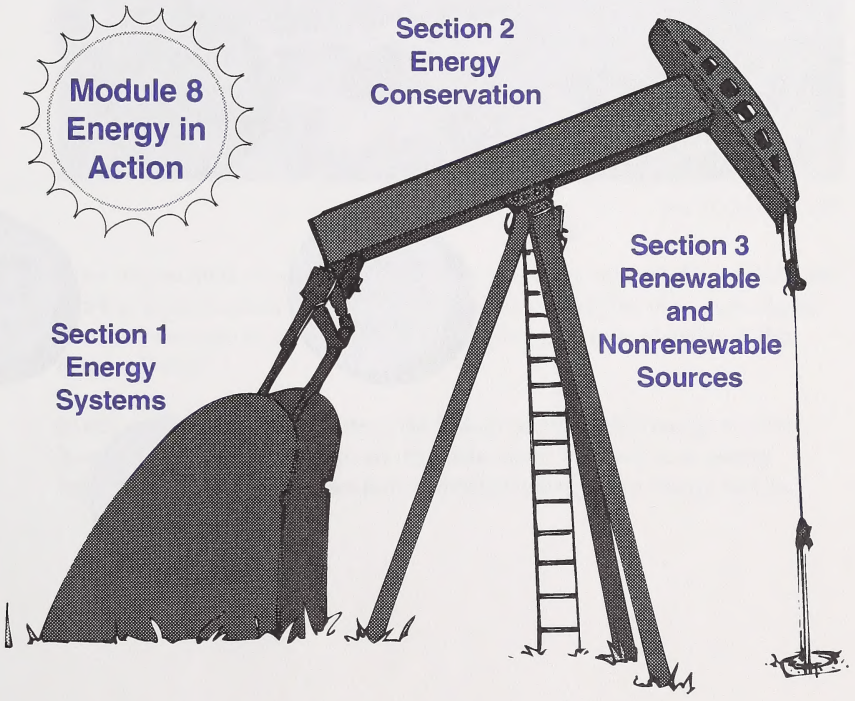
What do your body, a refrigerator, and the universe all have in common? Your studies from the previous module should give you a clue.

The fact that each of these examples consumes energy through energy conversions to sustain its functions is the common attribute. Since each example appears to function separately, each is classified as an energy system.

In this module you should develop an understanding of what an energy system means, and you should also be able to describe the components of such an energy system.

In analysing energy systems, the law of conservation of energy is an important consideration. Its principles form the basis for calculating efficiencies of energy systems. When you are able to recognize the components of such energy systems, you should be able to suggest ways in which their efficiencies can be improved.

But the efficient operation of any energy system is not the only concern. Is there an everlasting source of energy? In the end, sources of renewable and nonrenewable energy will also be identified. This recognition should result in the efforts that you can make towards conserving these valuable energy sources.

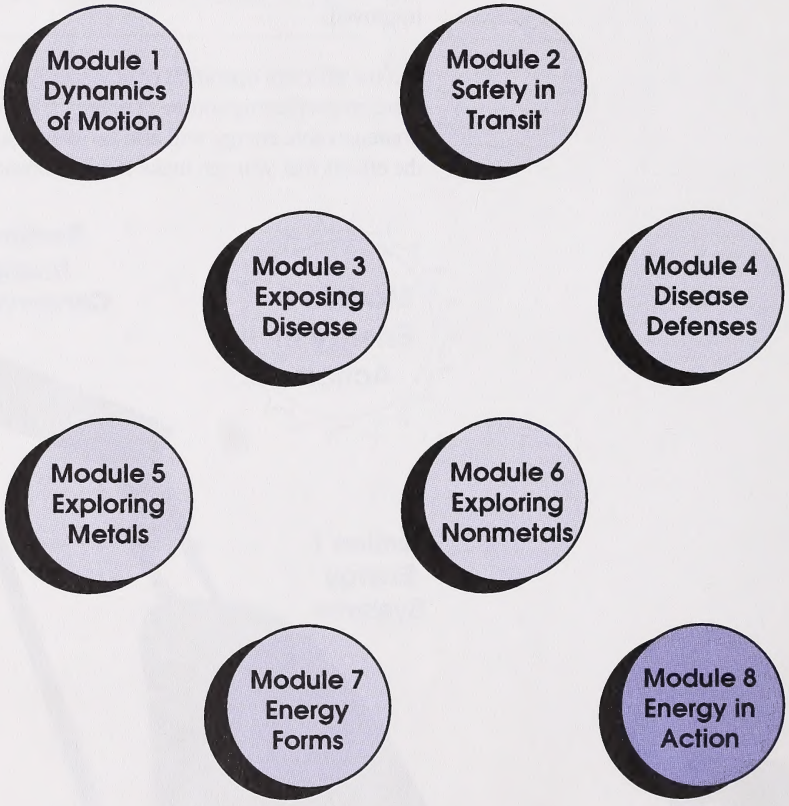


Evaluation

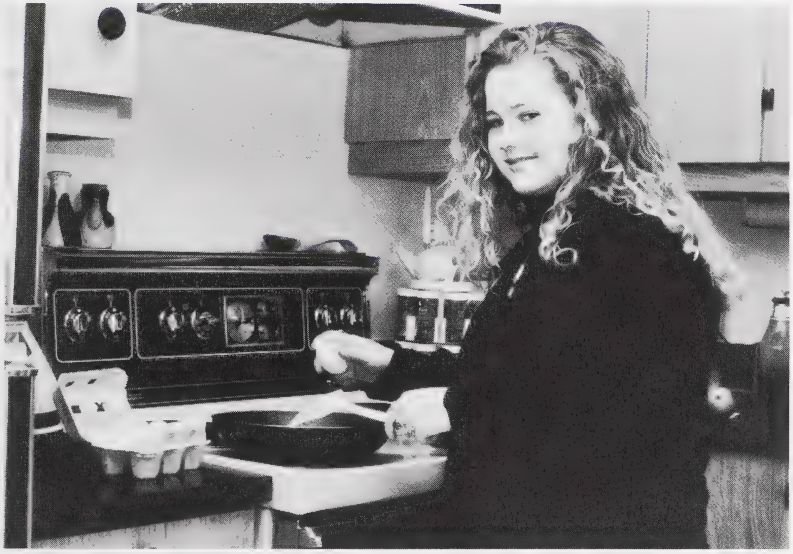
Your mark in this module will be determined by your work in the assignment booklet. You must complete all assignments. In this module you are expected to complete three section assignments. The mark distribution is as follows:

Section 1 Assignment	**35 marks**
Section 2 Assignment	**30 marks**
Section 3 Assignment	**35 marks**
TOTAL	**100 marks**

Course Overview



1 Energy Systems



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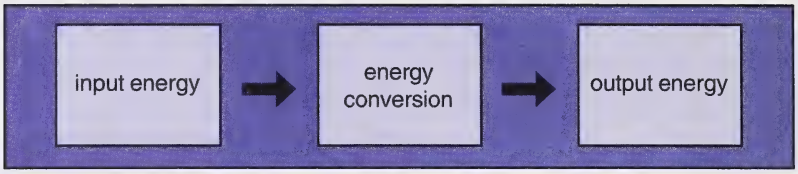
What do you think of when you think about an energy system? You might think of a big, noisy machine that has steam or smoke pouring out of it. Actually an energy system can be as simple as this girl frying eggs or as complex as the entire universe.

In this section you will learn about the flow of energy within energy systems. You will learn how more than one organism can be involved in an energy system. Finally, you will learn how to measure energy in an energy system.

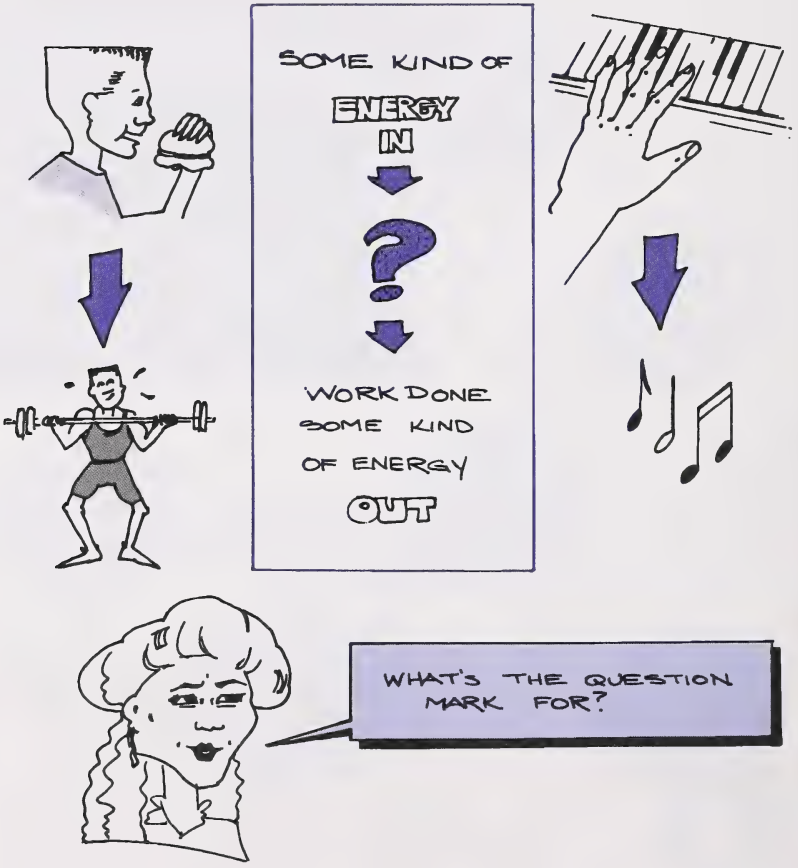
Activity 1: Energy In and Out

Energy is the ability to do work. You probably use a large number of devices to do work for you. Therefore, you must use energy.

The parts of an energy system are shown in the following diagram.

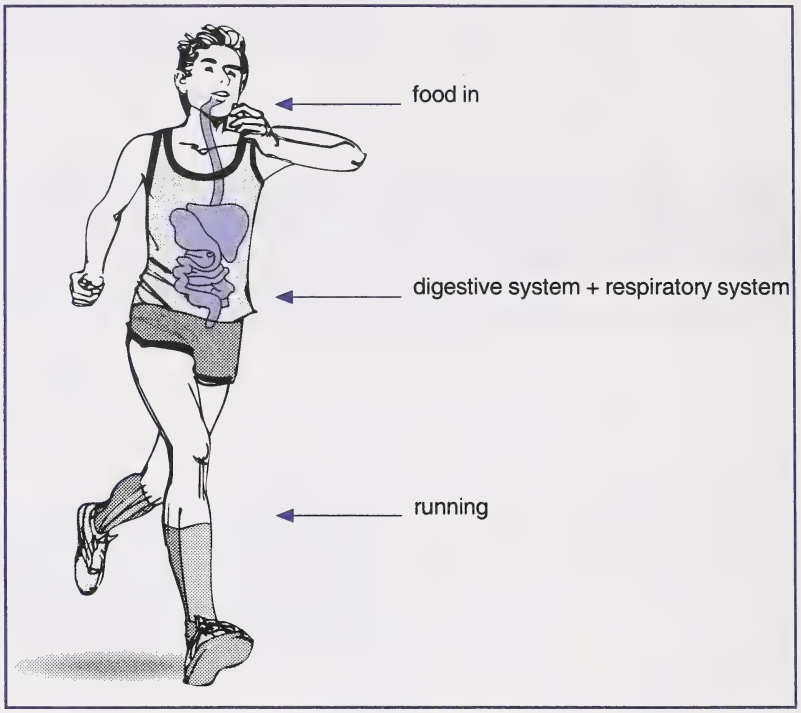


Any energy system can be thought of like this:



WELL - WHAT HAPPENS INSIDE YOUR BODY OR INSIDE THE PIANO?
HMM. YOU EAT AND THEN YOU EXERCISE. YOU PLAY A KEY AND THEN YOU HEAR A NOTE.
SURE BUT WHAT KIND OF ENERGIES ARE INVOLVED? FOOD IS CHEMICAL POTENTIAL ENERGY. EXERCISE AND NOTE PLAYING ARE MECHANICAL ENERGY, AND A MUSICAL NOTE IS SOUND ENERGY.
THE ENERGY IS CHANGING TYPES?
EXACTLY! THAT'S WHAT AN ENERGY SYSTEM IS.

Look at the following graphic showing the flow of energy of the human body.



1. Identify the three parts of an energy system shown in the illustration of energy flow in the human body.

   input energy: _____

   energy conversion: _____

   output energy: _____

Plants produce food (glucose) from carbon dioxide and water in the presence of sunlight. This process is called photosynthesis.

$$6\,CO_2 + 6\,H_2O \xrightarrow{\text{light, chlorophyll}} C_6H_{12}O_6 + 6\,O_2$$

carbon dioxide + water → glucose + oxygen

Notice that glucose is made of three elements: carbon (C), hydrogen (H), and oxygen (O).

2. What elements make up carbon dioxide and water?

_____, _____, _____

Plants use sunlight's energy to pull water and carbon dioxide molecules apart so the elements can be rearranged into glucose.

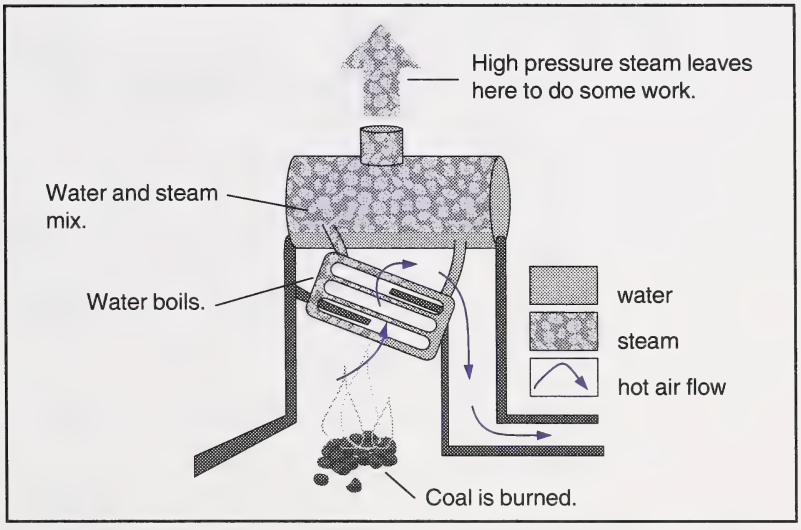
3. Name the three parts of an energy system represented in photosynthesis.

input: _____

conversion: _____

output: _____

A steam engine works like this:



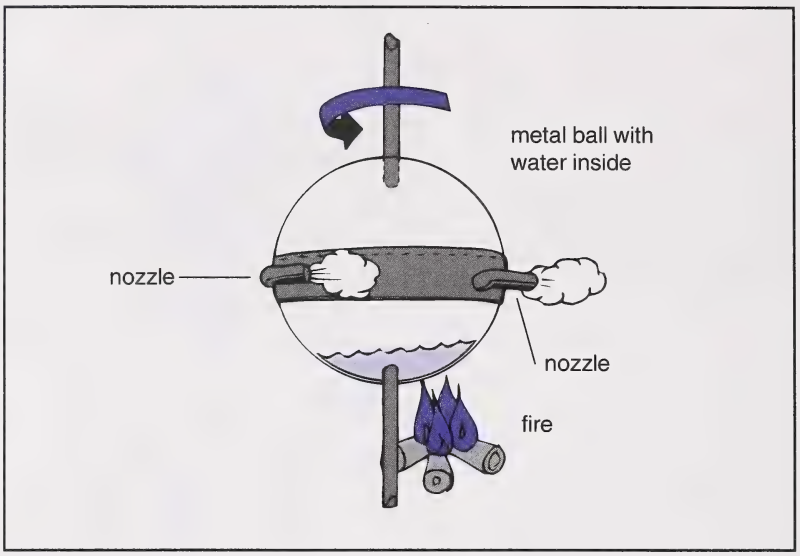
4. Name the components of the energy system shown in the illustration of the steam engine.

input: _____

conversion: _____

output: _____

The following diagram is of a device called Hero's engine. It's the world's first steam engine.

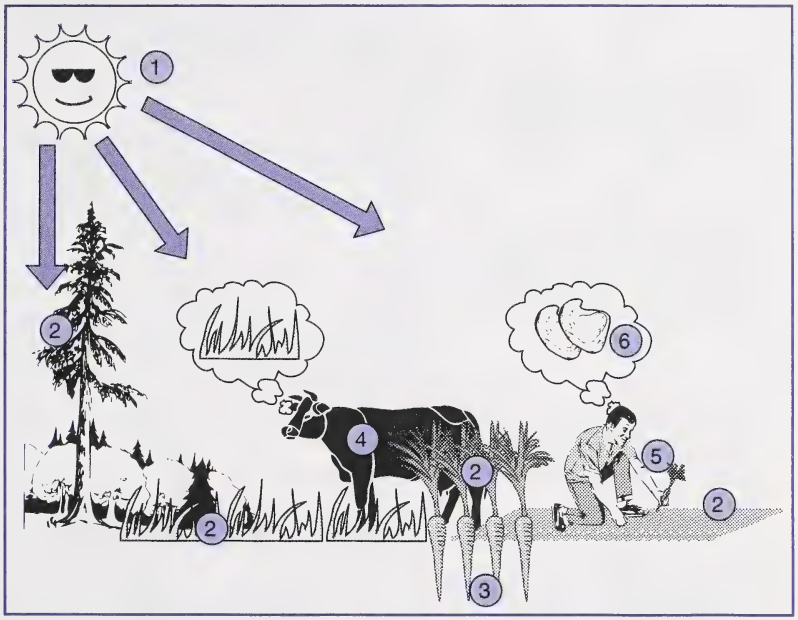


5. Explain how Hero's engine works.

Check your answers by turning to the Appendix, Section 1: Activity 1.

Activity 2: More Than One Organism

Not only can you trace energy flow through one person, you can trace this flow through a whole ecosystem of any size you like. Look at this food chain:



Energy conversions in the previous illustration are as follows:

1. Solar energy is the start of the energy system.
2. Plants convert solar energy to chemical energy (glucose).
3. Plants store food in the form of starch (carbohydrates).
4. The cow eats grass and converts the energy into fat, milk, and muscles.
5. The person eats carrots and converts carbohydrates into mechanical energy.
6. The person eats steak, which would be converted to human tissues and mechanical energy.

1. a. Fill in the following chart showing the energy input and output for the cow and the person.

	Input	Output
cow		
person		

b. What is the original energy input?

_____

2. Identify the energy system parts shown in the car.

input: _____

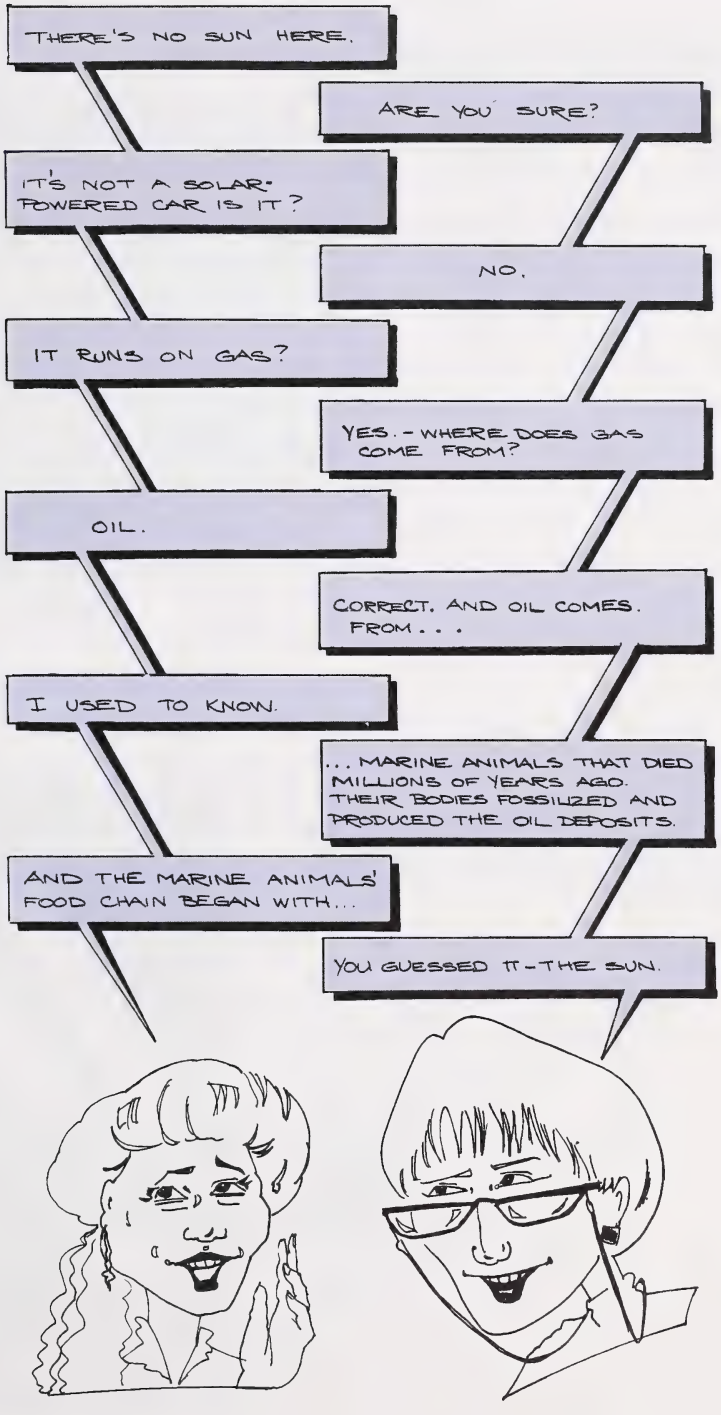
conversion: _____

output: _____

SO YOU CAN TRACE ENERGY FROM ONE ORGANISM TO ANOTHER?! DO ALL ENERGY SYSTEMS START FROM THE SUN?
ECOSYSTEMS DO. MOST OTHER SYSTEMS DO TOO. LOOK AT THIS ONE.

ENERGY SYSTEM - A CAR

Check your answers by turning to the Appendix, Section 1: Activity 2.


THERE'S NO SUN HERE.
ARE YOU SURE?
IT'S NOT A SOLAR-POWERED CAR IS IT?
NO.
IT RUNS ON GAS?
YES. - WHERE DOES GAS COME FROM?
OIL.
CORRECT. AND OIL COMES FROM...
I USED TO KNOW.
... MARINE ANIMALS THAT DIED MILLIONS OF YEARS AGO. THEIR BODIES FOSSILIZED AND PRODUCED THE OIL DEPOSITS.
AND THE MARINE ANIMALS' FOOD CHAIN BEGAN WITH...
YOU GUESSED IT - THE SUN.

Look at the fuels used in everyday life and see where they come from as shown in the following table.

Fuel	Origin
gasoline, propane, oil, natural gas, other petrochemicals	marine animals fossilized in ancient ocean beds
coal	forests of ancient trees fossilized and deposited in ancient ocean beds
natural gas	animal and plant material broken down or decomposed (rotted)
wood	trees

All from the Sun

Any living organism (or one that used to be living) has the sun as its original source of energy. All ecosystems have the sun as the primary energy source.

HEY! NUCLEAR ENERGY! IT'S FROM URANIUM NOT THE SUN!
GOOD POINT. URANIUM WAS PRESENT ON THE EARTH WHEN THE EARTH AND SUN WERE FORMED.

RIGHT! AND WE USE THE ENERGY INSIDE THE ATOMS OF URANIUM TO PRODUCE ELECTRICITY
CORRECT. BUT THE URANIUM IS MINED, AND PURIFIED FIRST USING FOSSIL FUELS. THERE'S THE SUN CONNECTION

Activity 3: Measuring an Energy System

In Module 7 you learned that energy is measured in joules (or some multiple of joules). Recall that one joule (J) is equal to the work done lifting a one newton weight, one metre.

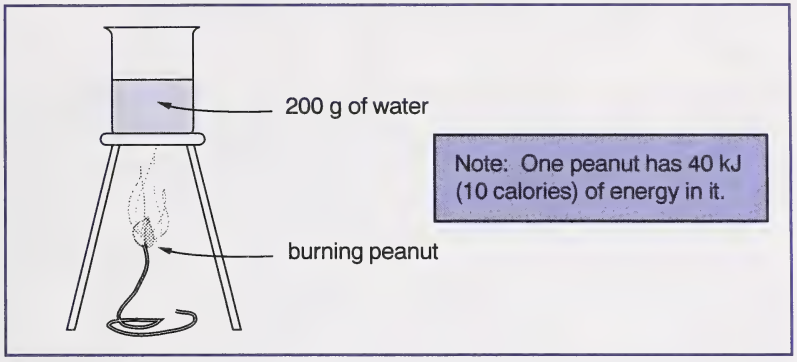
$$1J = 1N \cdot m$$

Output energy is **always** less than input energy.

This is true for any energy system in everyday life. So if you want to do 100 J of work you will have put in **more than** 100 J of energy to do it!

HOLD IT! HOW COME YOU'RE CALLING IT WORK ONE TIME AND ENERGY ANOTHER?
ENERGY IS DEFINED AS THE ABILITY TO DO WORK. 1 JOULE OF ENERGY CAN DO 1 JOULE OF WORK SO IT'S OK TO MIX THEM.
WHICH ONE IS BEST TO USE?
THE ONE THAT'S EASIER TO MEASURE, IT DEPENDS ON THE SITUATION.

Look at the amounts of energy involved in a calorimeter experiment.



If the peanut raises the water temperature from 10°C to 45°C, then the output energy is:

Energy = 200 g × 35° change × 4.2
= 29 400 J
= 29.4 kJ

The energy input is 40 kJ according to any food chart, so the output energy is less than the input energy.

1. a. Where has the extra (or lost) energy gone? (Hint: It's heat energy too.)

_____

_____

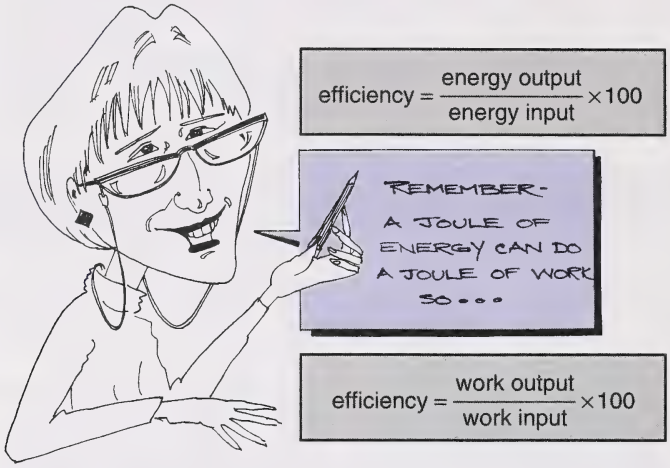
_____

_____

b. What percent of the input energy ends up in the water as output energy?

efficiency – the ratio of output energy to input energy (or work) expressed as a percent

The percent of input energy that actually makes it to output energy is called the **efficiency** of the energy system.


efficiency = energy output / energy input × 100
REMEMBER-
A JOULE OF ENERGY CAN DO A JOULE OF WORK
SO...
efficiency = work output / work input × 100

2. a. Suppose a machine does 500 J of work after you put 1000 J of energy into it. Calculate its efficiency.

b. A car is 50% efficient (that's excellent for a car). If you get 100 000 000 J of work out of it, how much energy was put into it?

Check your answers by turning to the Appendix, Section 1: Activity 3.

Energy efficiency is summarized in the following table.

Efficiency is **always** less than 100%.

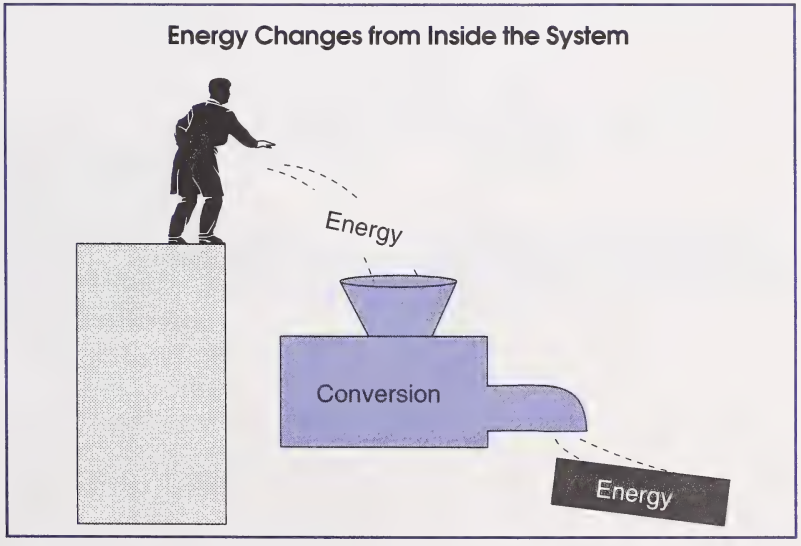
Device or System	Efficiency
plant photosynthesis	4%-7%
car	20%
jet engine	20%-25%
nuclear power plant	30%

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

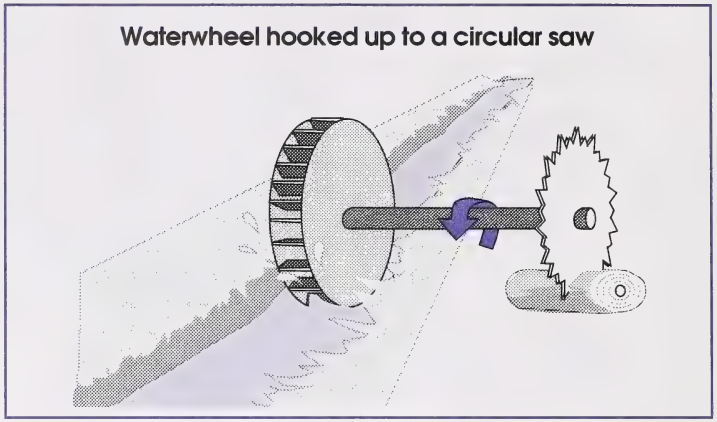
An energy system can look like anything. Useful energy comes out after some kind of energy is put in (like an energy machine).



The trouble is that less energy comes out after conversion. There's always some energy lost. The percent that isn't lost is the efficiency of the system.

1. Label the input, conversion, and output in these systems:

a.

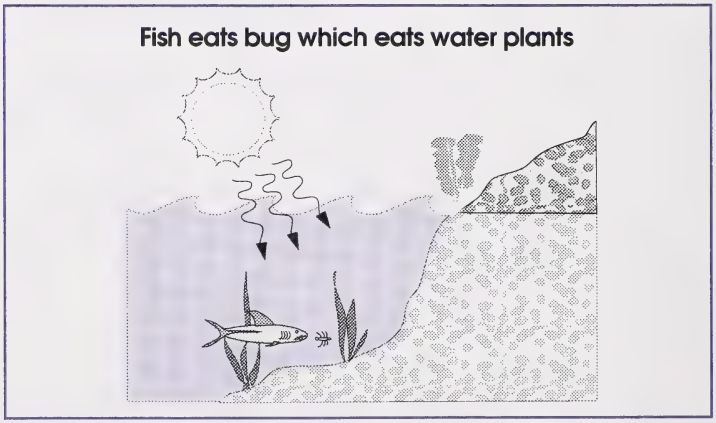


input: _____

conversion: _____

output: _____

b.



input: _____

conversion: _____

output: _____

2. If you put 60 J of energy into a system and got 15 J of energy out, what would the efficiency of the system be?

3. Suppose you do 500 J of work pushing a box up a ramp. If you could lift the box straight up instead and doing this would require only 400 J of work, then how efficient is the ramp?

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

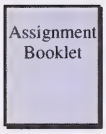
1. How efficient are automobiles? Are bicycles more or less efficient than automobiles? You may have to research this.

2. If a device were 100% efficient, then output energy would equal input energy, and, once started, the device would work forever. Such a device is called a perpetual motion machine. Try to design one.

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

You studied energy systems in this section. You learned how to identify the components of energy systems. You discovered that they always seem to lose some energy. Finally, you saw that even living things and ecosystems can be thought of as energy systems.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

2 Energy Conservation

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If you were to boil water for tea, how would you do it? Would you choose an energy efficient method? Would energy be lost with the method you choose? Could the lost energy be recovered and reused?

Although you may not be aware of it, these types of decisions are made all the time. Sometimes it can involve a simple task such as making tea, or it can involve deciding which method of transportation you should use.

In this section you will learn about conserving energy. You will learn about the importance of an efficient energy system. You will also be comparing energy systems to find the best system.

Activity 1: The Conservation Law

conservation – the principle that some part of a system is not changed after undergoing some event; it is conserved

Conservation means that something isn't changing. If the total amount of something (mass) stays constant during some event, then it is said that the mass has been conserved.

Do you recognize the statement, "Mass is conserved in a chemical reaction?"

To see this for yourself, try this investigation.

Investigation: Is Mass Conserved?

In this investigation you will use a chemical reaction to determine if mass is conserved.

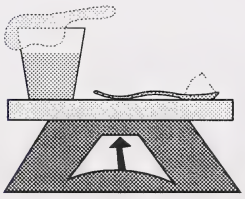
Materials You Need

- lemonade
- baking soda
- drinking glass
- spoon
- plastic wrap (or other air tight lid for the glass)
- kitchen scale (optional)

Steps to Follow

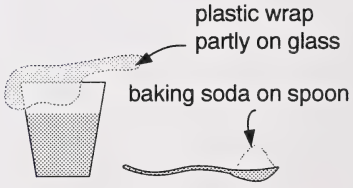
STEP A

Weigh all the materials shown in the diagram: glass and lemonade, plastic wrap, spoon, and baking soda.



STEP B

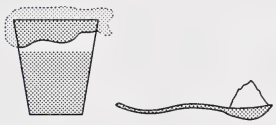
Set up the materials so you can add one spoonful of baking soda to a glass 3/4 full of lemonade and cover it quickly.



STEP C

Add the baking soda to the glass and cover it quickly.

Set the spoon down and record what you see happening.



STEP D

Weigh all the materials again. Don't leave anything out when you do this.

Record any difference in weight.

Observations

1. a. What happened when you added the baking soda?

_____

_____

_____

b. How much did the weight change?

_____

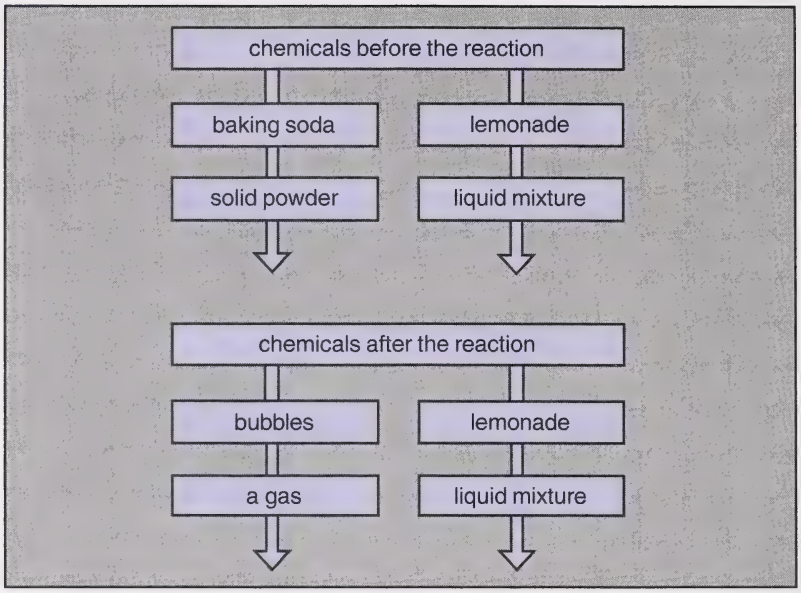
_____

Check your answers by turning to the Appendix, Section 2: Activity 1.

Conclusion

The baking soda chemically reacts to produce other products including a gas (carbon dioxide). The mass didn't change. Mass was conserved in this reaction.

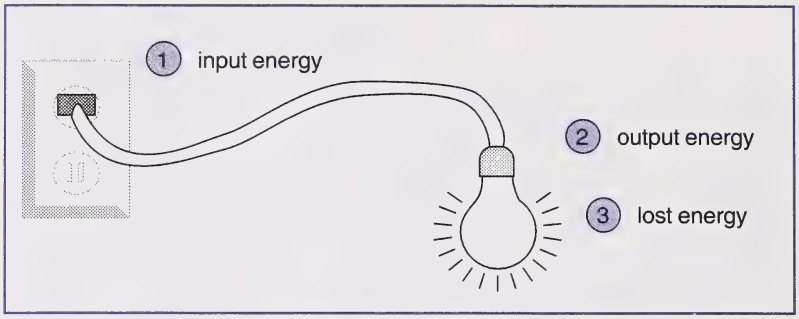
Look at the following illustration.



The law of conservation of energy states that in every energy system the total amount of energy stays the same. Scientists haven't found any system that fails to follow this law.

HOLD IT RIGHT THERE! YOU TOLD ME THAT ENERGY IS LOST BY ALL SYSTEMS.
I THOUGHT I SAID THAT OUTPUT ENERY IS LESS THAN INPUT ENERGY.

ISN'T THAT THE SAME THING?
NOT QUITE. OUTPUT ENERGY IS USEFUL FOR DOING WORK THE ENERGY MADE BY THE CONVERSION ISN'T ALL USEFUL.
I'M NOT SURE I GET IT. CAN YOU GIVE ME AN EXAMPLE?
A READING LIGHT. IT'S SUPPOSED TO PRODUCE LIGHT BUT HAVE YOU EVER TOUCHED ONE?
SURE IT'S HOT. SAY, YOU MEAN THE HEAT MIGHT BE THE MISSING ENERGY?
EXACTLY LOOK AT THIS DIAGRAM OF THE LIGHT AS AN ENERGY SYSTEM.



1. The 100 W bulb draws 100 J of energy from the household electricity every second.

2. The electric energy is converted to light by the heated filament. Only about 20% of the input is turned into light.

3. The heat given off doesn't help you see. It seems to be lost. It represents about 80% of the total input energy.

Every second, 100 J of energy goes into this system and 100 J goes out.

The total is constant. However only 20% of the total output is useful light. The light is 20% efficient. The rest of the output energy is lost as heat.

2. Look at these systems and explain where the lost energy is. Remember, it's still there but not useful for the purpose of the energy system.

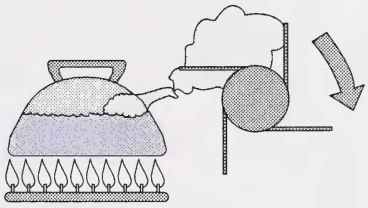
a.

- consumes 8000 kJ of energy each day
- gets about 2000 kJ of mechanical energy out of it

b.

- eats a piece of chicken and gets 500 kJ of energy from it
- chicken ate several times as much energy to produce the leg

c.



- one million joules of heat energy is used to boil the water
- a tiny fraction of that turns the wheel

Remember: Efficiency is $\frac{\text{useful energy output}}{\text{energy input}} \times 100$

Check your answers by turning to the Appendix, Section 2: Activity 1.

Activity 2: Energy System Efficiency

The key word that describes how well an energy system works is *efficiency*. A perfect system is 100% efficient. Most of the systems people use are nowhere close to this.

Did You Know?

In the 1970s an energy institute estimated the total of human technology to be about 4% efficient.

1. Consider the following systems and rate them as low or high efficiency.

   a. an ox-driven plough on farmland

   _____

   b. a person on a bicycle travelling 15 km/h for one hour

   _____

   c. an electric light bulb

   _____

   d. a plant making food from sunlight

   _____

Check your answers by turning to the Appendix, Section 2: Activity 2.

Most of the systems used are not very efficient. The wasted energy is often in the form of heat.

Do **one** of the following investigations.

Investigation: How Good Is a Stove?

In this investigation you will determine the efficiency of a stove.

Materials You Need

- electric stove top
- pot of water
- measuring cup
- clock
- thermometer

Steps to Follow

STEP A

Measure 500 mL of cold water into the pot. Remember that 500 mL of water equals 500 g water. Record the temperature of the water.

STEP B

Put the pot of water on the stove. Turn on the stove to high and time how long it takes to get the water boiling.

Observations

Cold water temperature _____

Time to boil the water _____

Time in seconds _____

Calculations

A stove burner on high is about 2500 W. It uses 2500 J of electricity each second.

2. Multiply the number of seconds it took to boil the water by 2500. This is the input energy.

_____

_____

It takes 4.2 J of energy to raise 1 g of water 1°C. To find energy output, you must first find how much the water temperature changed. Note that because Alberta is above sea level, water boils below 100°C. Therefore, 98°C is used as the boiling point of water.

3. a. Subtract your starting temperature from 98°C to find the temperature change.

b. To find the useful energy output use the following formula.

$$4.2 \text{ J/g} \bullet \text{C}^\circ \times \Delta t \times 500 \text{ g}$$

c. Find the efficiency from the following formula: $\frac{\text{ouput energy}}{\text{input energy}} \times 100$

Conclusions

3. a. No stove is 100% efficient. Name two places where energy that is not useful has gone.

_____

_____

b. Suggest two ways that the system could be improved (ways to boil water faster).

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 2.

Investigation: How Efficient Is Your Body at Turning Food and Oxygen into Energy?

In this investigation you will determine how well your body can convert food and oxygen into energy when you exercise.

Whenever you exercise, you use up the ATP stored in your cells. Once this **ATP** is gone, your body must get food and oxygen into your cells to make more ATP. How well your body does this is called **aerobic fitness**.

ATP (adenosine triphosphate) – a high-energy compound found in cells for storage and transfer of energy

aerobic fitness – a body's ability to convert food and oxygen into ATP as it enters the body's cells

Materials You Need

- a car odometer

Steps to Follow

STEP A

Run or walk (or both) as far as you can in a 12 min period of time.

Have a parent or a friend follow you in a car.

STEP B

Measure and record the distance you travelled to the nearest 100 m or (0.1 km). A car odometer measures this precision.

Look up your fitness level in the following table.

Fitness Chart			Distance travelled in km	
Fitness Category			Age (years)	
			13-19	20-29
I	very poor	men women	less than 2.1 less than 1.6	less than 2.0 less than 1.5
II	poor	men women	2.1 - 2.2 1.6 - 1.9	2.0 - 2.1 1.5 - 1.8
III	fair	men women	2.2 - 2.5 1.9 - 2.1	2.1 - 2.4 1.8 - 2.0
IV	good	men women	2.5 - 2.8 2.1 - 2.3	2.4 - 2.6 2.0 - 2.2
V	excellent	men women	2.8 - 3.0 2.3 - 2.4	2.6 - 2.8 2.2 - 2.3
VI	superior	men women	more than 3.0 more than 2.4	more than 2.8 more than 2.3

Observations

Distance travelled (km) _____

Fitness category _____

Conclusions

4. a. Why do you have to run for 12 min instead of a shorter sprint?

_____

_____

b. How can you improve the efficiency of your aerobic system?

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 2.

Activity 3: Comparing Two Systems

energy efficient – a system that has been designed to use less energy or have a higher efficiency

You are always making decisions about how to do things. Some ways are **energy efficient** and some are not. Look at these examples.

Task	Energy System 1	Energy System 2
boil water	use an electric kettle	use a microwave
get protein in your diet	eat meat	eat soybean
go to the store	walk	take a car
produce electricity	use solar cells	use hydroelectric power stations

In each case there are different energy systems you can use. The output energy is the same no matter which system you choose. The most efficient system will lose the least amount of energy (usually as heat). In order to compare two systems, you must be able to measure the energy use for each one. That's easy for some systems and hard for others.

1. Look at the previous chart. For each task, write down the method that you think is most energy efficient.

   a. boil water

   _____

   _____

   b. get protein

   _____

   _____

   c. go to the store

   _____

   _____

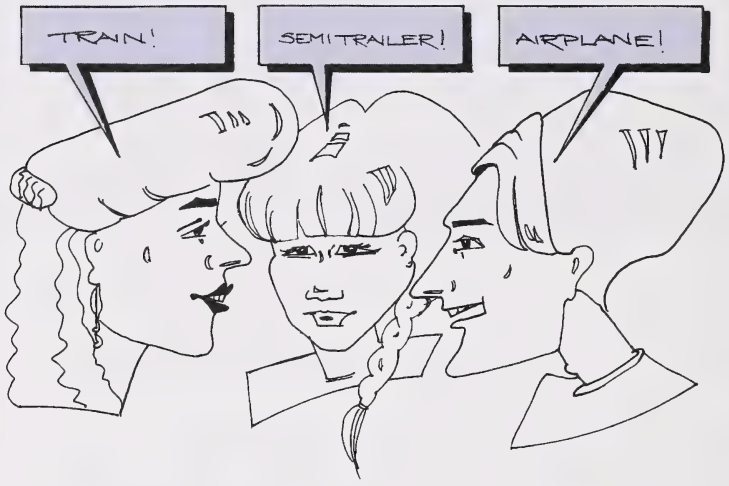
d. produce electricity

_____

_____

Canadians are among the **worst** energy users in the world, averaging more energy use per person than almost every other country. Why is all this energy used? Convenience!

2. What do you think is the most energy efficient way to transport goods long distance?

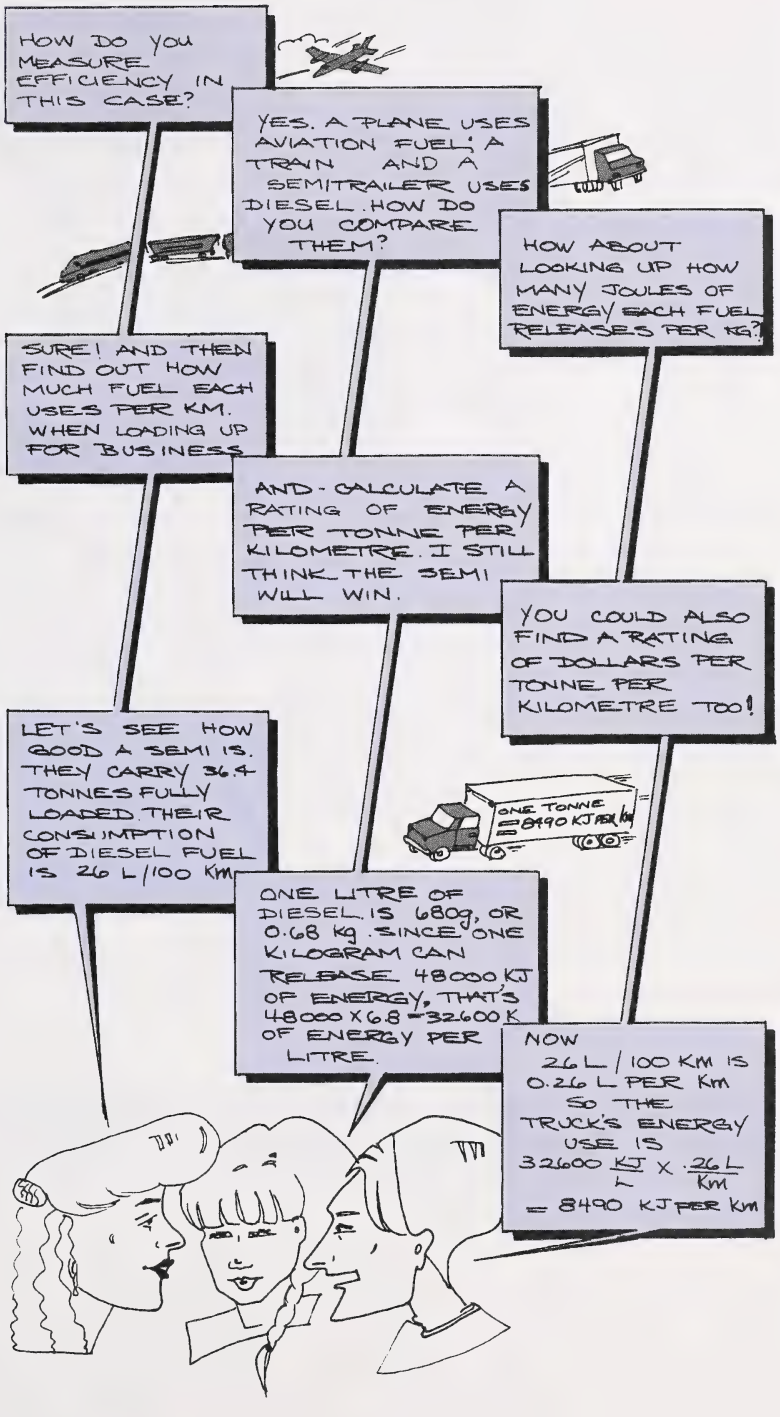


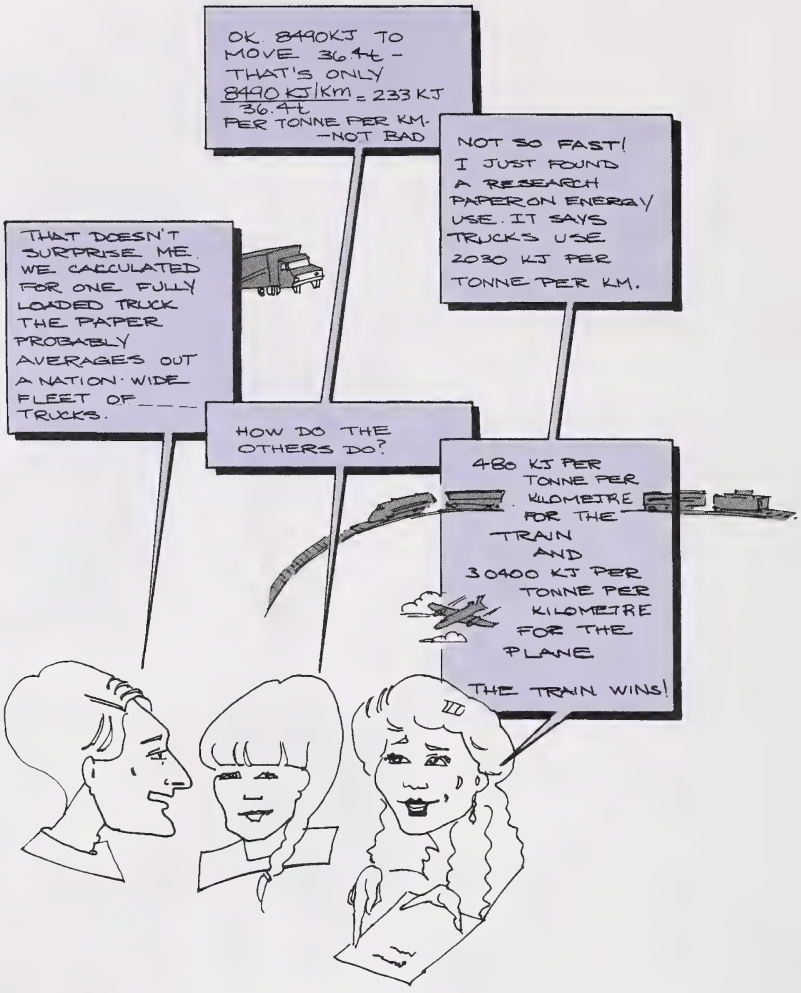
Write your prediction here.

_____

_____

The task is to haul a one tonne (1000 kg) package from Vancouver to Calgary.


HOW DO YOU MEASURE EFFICIENCY IN THIS CASE?
YES. A PLANE USES AVIATION FUEL, A TRAIN AND A SEMITRAILER USES DIESEL. HOW DO YOU COMPARE THEM?
HOW ABOUT LOOKING UP HOW MANY JOULES OF ENERGY EACH FUEL RELEASES PER KG?
SURE! AND THEN FIND OUT HOW MUCH FUEL EACH USES PER KM. WHEN LOADING UP FOR BUSINESS
AND - CALCULATE A RATING OF ENERGY PER TONNE PER KILOMETRE. I STILL THINK THE SEMI WILL WIN.
YOU COULD ALSO FIND A RATING OF DOLLARS PER TONNE PER KILOMETRE TOO!
LET'S SEE HOW GOOD A SEMI IS. THEY CARRY 36.4 TONNES FULLY LOADED. THEIR CONSUMPTION OF DIESEL FUEL IS 26 L/100 KM
ONE TONNE = 8490 KJ PER KM
ONE LITRE OF DIESEL IS 680g, OR 0.68 kg. SINCE ONE KILOGRAM CAN RELEASE 48000 KJ OF ENERGY, THAT'S 48000 X 0.68 = 32600 KJ OF ENERGY PER LITRE.
NOW 26 L / 100 KM IS 0.26 L PER KM SO THE TRUCK'S ENERGY USE IS 32600 KJ/L X 0.26 L/KM = 8490 KJ PER KM


OK. 8490KJ TO MOVE 36.4t - THAT'S ONLY 8490 KJ/km / 36.4t = 233 KJ PER TONNE PER KM. -NOT BAD
NOT SO FAST! I JUST FOUND A RESEARCH PAPER ON ENERGY USE. IT SAYS TRUCKS USE 2030 KJ PER TONNE-PER KM.
THAT DOESN'T SURPRISE ME. WE CALCULATED FOR ONE FULLY LOADED TRUCK. THE PAPER PROBABLY AVERAGES OUT A NATION-WIDE FLEET OF ____ TRUCKS.
HOW DO THE OTHERS DO?
480 KJ PER TONNE PER KILOMETRE FOR THE TRAIN AND 30400 KJ PER TONNE PER KILOMETRE FOR THE PLANE
THE TRAIN WINS!

3. List one advantage of using each transportation type.

   a. semitrailer

   _____

   _____

b. plane

_____

_____

c. train

_____

_____

4. a. Why is a train a high efficient user of energy?

_____

_____

_____

b. Why is a semitrailer truck an adequate user of energy?

_____

_____

_____

c. Why is an airplane an inefficient user of energy?

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 3.

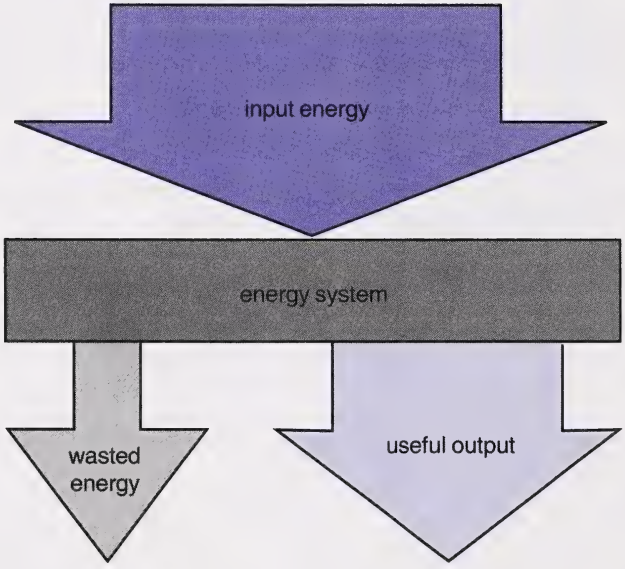
Follow-up Activities

If you had difficulty understanding the concepts in the activities of this section, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

To help you master the concept of energy conservation, consider the following explanations and questions.

The total energy of a system is constant. If energy seems to be lost, then it has been converted to a nonuseful form like heat.



1. A car engine gets so hot when in use that an entire cooling system is needed to prevent it from melting. The gasoline not only supplies the energy to move the car but it must run a water pump for the cooling system as well. Give two reasons why a car engine gets so hot.

A system that is 75% efficient is losing 25% of the input energy. (It is converting that 25% into nonuseful forms of energy.) Biological systems and mechanical systems both follow the same rules. Here are some system efficiencies:

Biological		Mechanical	
photosynthesis	4-7%	cars	about 20%
respiration (cellular)	40%	nuclear power plant	30%
first step in a food chain	10%	coal power plant	35%
		hydroelectric plant	90%

Each step of a food chain is only 10% efficient.

2. a. Suppose you are a vegetarian. What percent of the sun's energy do you get from your food?

_____

_____

b. If 10% of the food you eat is muscle and fat, what percent of the sun's energy is transformed into your body?

_____

_____

c. If you eat a cow (steak) and the cow eats grass, what percent of the sun's energy is transformed into your body?

_____

_____

If you must compare two systems, they have to be compared on equal terms. In transportation, you see terms like *energy per tonne•kilometre*.

3. Match the energy comparison unit with the system it is used for.

Energy System		Unit for Comparison
____ a.	generating electricity by burning coal	i. energy per passenger•kilometre
____ b.	car travel	ii. kilograms per hectare•year
____ c.	yield of wheat crop	iii. watts per tonne

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

1. A Boeing 767 is one of the most efficient airplanes around. Do some research on efficiencies of airplanes. How good is a four-seater Cessna?

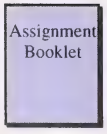
2. Can vegetarians get all the protein and vitamins they need? If so, from which plants can they get them?

3. Do some research on energy expenditure of mammals. Which mammal uses the least energy? Which mammal uses the most energy?

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

This section looked at the measure of energy in a system. You learned that the total amount of energy in a system is constant but that some input energy is converted into nonuseful energy. You also saw ways to improve and compare systems.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

Section

3 Renewable and Nonrenewable Resources

AOSTRA

What if there is no more energy for future needs? What can be done for energy resources to be used more efficiently? The fact remains that society depends on energy.

In this section you will consider different energy resources. You should be able to identify those that are renewable and those that are not.

You will look at the effects of using nonrenewable resources and determine if renewable ones can be used more effectively. Energy alternatives are always possible, but there are social and political costs and considerations.

Activity 1: Definitions of Energy Types

There are many ways to classify energy. Look at the following chart. It shows one classification:

Energy	
high-grade	• high concentration of energy in one place
low-grade	• low concentration of energy • very spread out

high-grade energy – energy in a concentrated form
eg. oil, coal

low-grade energy – energy that is not in a concentrated form
eg. waste heat

renewable – a source of energy that can be replaced in a lifetime or less

nonrenewable – a source of energy that cannot be replaced in a lifetime

hydroelectric – making electricity by using a waterfall to run a turbine

High-grade energy is easier to do work with than **low-grade energy**. Humans are always searching for high-grade energy resources like oil. The heat produced and lost in an energy system is low-grade energy. It isn't very useful.

There are two kinds of high-grade energy sources.

Renewable sources are energy sources that can be replaced by man or nature in a relatively short time after they have been used. **Nonrenewable** sources can't be replaced once they have been used.

People will use the easiest energy source that they can. Today's world economy runs on oil. Nature spent millions of years concentrating chemical energy into oil and natural gas. If chemical energy can be found and refined, there would be a tremendous source of energy. Gasoline releases 48 000 000 J of energy per kg when burned! Oil is nonrenewable. Once all the oil deposits have been pumped, they are gone and can't be replaced.

Hydroelectric dams are renewable energy sources. As water falls down the dam, it turns turbines to generate electricity. As long as climates are stable, rainfall and spring runoff will keep the dam's reservoir full so there is always more water to fall.

There aren't very many places in Alberta where the conditions for hydroelectric power are favourable though. Alberta has a few small places only (the Brazeau Dam at Lodgepole, for example); many countries have none.

1. Classify the following energy sources as nonrenewable or renewable.

   a. windmills: _____

   b. coal: _____

   c. solar: _____

   d. nuclear: _____

   e. wood: _____

Look at this chart:

Energy Resources	
Nonrenewable	**Renewable**
oil coal natural gas nuclear	solar wind geothermal tidal water biofuels – wood – methane – alcohol

2. Look at the list of nonrenewable sources. On which of these energy sources does Alberta's economy depend?

   _____

   _____

fossil fuels – fuel from fossil remains of living things

Oil, coal, and natural gas are called **fossil fuels**. An ancient inland sea covered Alberta millions of years ago. The fossil fuel resources Alberta has today are from that sea.

People are slowly realizing that they must start conserving energy to protect the environment and to make sure that they have energy in the future.

3. How will this affect Alberta's economy?

_____

_____

_____

_____

4. Look at the list of renewable sources. On which of these energy sources does Alberta depend?

_____

_____

Check your answers by turning to the Appendix, Section 3: Activity 1.

It seems that Alberta is better suited for nonrenewable energy use than renewable energy use.

Activity 2: Nonrenewable Energy Use

Look at the information charts on these two energy sources:

Nuclear Energy	
• the most concentrated energy source by far	• waste products include radioactive plutonium – very hard to store safely
• used to make bombs	• fusion reactors not developed yet
• used to make steam to drive turbines	• electricity is as inexpensive as hydroelectricity
• extreme radiation hazard – must be well protected	• plutonium can be purified to make bomb grade fuel

Fossil Fuels	
• oil, natural gas, coal	• fuels give off CO_2 to enhance the greenhouse effect
• most plentiful source of high-grade energy	• primary cause of smog is cars
• a major source of income in Alberta	• a source of air pollution with chemicals that cause acid rain
• coal used to power turbines to make electricity	• most oil comes from politically volatile places in the world
	• most economical way to get large amounts of energy

1. Name two positive aspects and two negative aspects of nuclear energy.

_____

_____

_____

_____

2. Name two positive aspects and two negative aspects of fossil fuels.

_____

_____

_____

_____

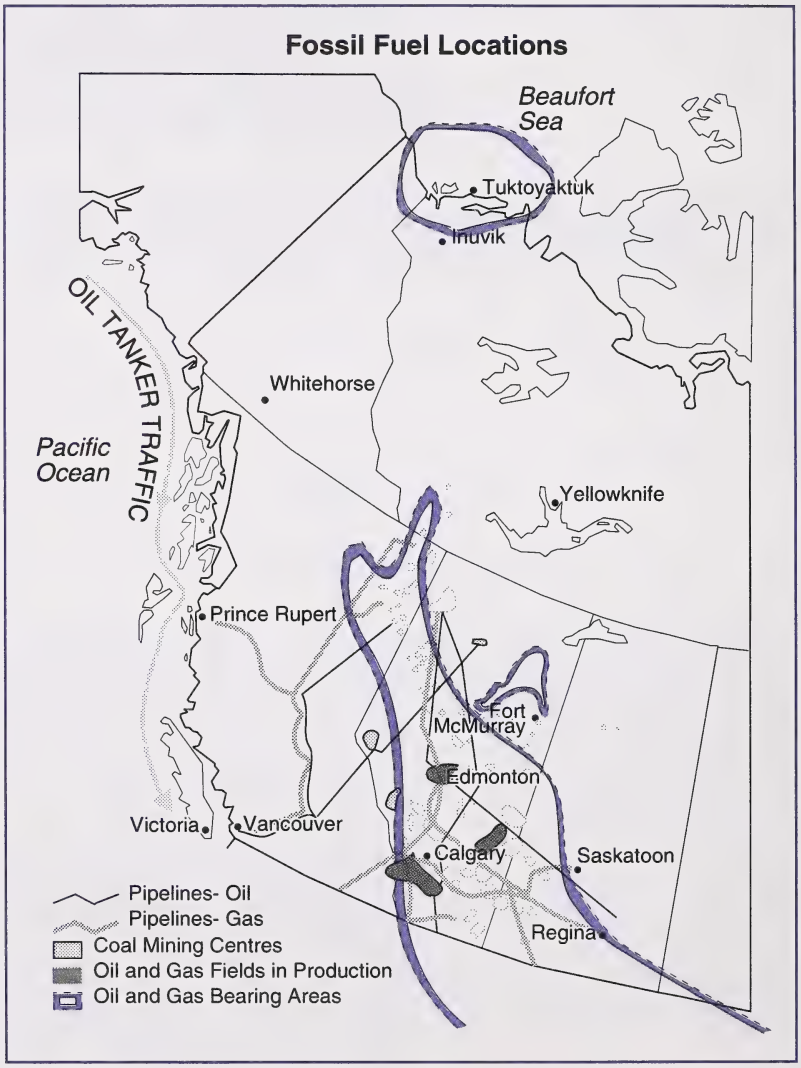
The following table shows how concentrated these energy sources are.

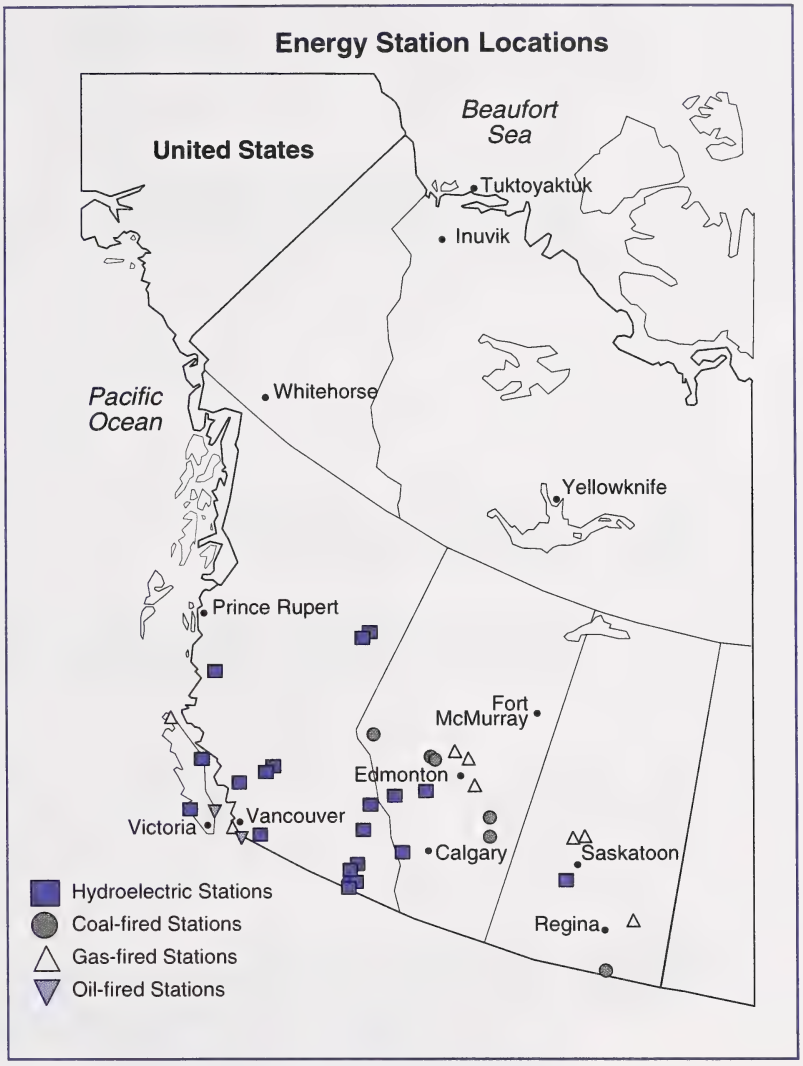
Energy Released per kg	
nuclear	90 000 000 000 000 000 J
gasoline	48 000 000 J
fuel oil (homes)	44 000 000 J
coal	28 000 000 J

Fossil fuels are the highest grade energy sources available except for nuclear energy sources. The following are disadvantages of fossil fuels:

- They are nonrenewable.
- Burning them produces pollution.
- Burning them produces carbon dioxide – a greenhouse effect gas.

Look at the following maps showing how to get and use fossil fuels. Then answer the questions that follow.





3. a. Where do most of the pipelines go to? (They come from oil and gas fields.)

b. Up in the Beaufort Sea there is a huge off-shore oil and gas area. Why develop this in such a cold climate? Why not develop alternate energy sources?

_____

_____

_____

_____

c. British Columbia has many more hydroelectric stations than Alberta. (The stations are larger too.) Why?

_____

_____

_____

d. Look at where the coal-fired plants are on the second map and the coal mining areas on the first map. What can you say about where the coal-fired plants are?

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 3: Activity 2.

Activity 3: Renewable Sources of Energy

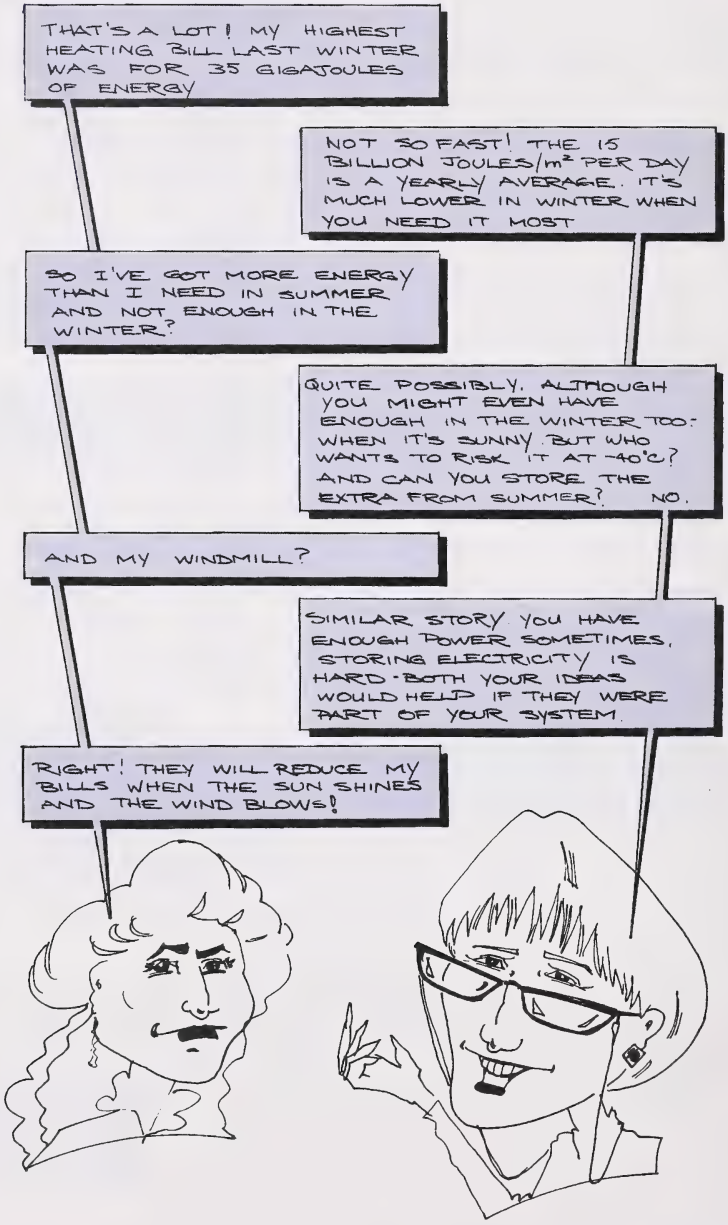
You probably have seen solar-powered calculators. No more batteries. The silicon solar cell converts light into electricity directly (at a 6-8% efficiency). The space program has solar cells that are just over 20% efficient, but they are very expensive. The main problem with solar energy is that it is lower energy density (lower grade energy). On the other hand, it's free and it is readily available.

Most renewable energy sources come from the sun. The Earth receives about 5×10^{24} (5 000 000 000 000 000 000 000 000) J of solar energy per year. Human technology doesn't produce even 1/100 of one percent of this amount! There must be room to exploit solar energy.

LET'S MAKE A SOLAR-HEATED HOUSE AND MAKE ELECTRICITY FROM A WINDMILL!
DEA!
E=?
ARE YOU SURE THAT YOU HAVE ENOUGH ENERGY?
ARE YOU KIDDING? DID YOU SEE THE SIZE OF THAT NUMBER? 24 ZEROS!
THAT'S THE SOLAR ENERGY FOR THE WHOLE EARTH! YOUR HOUSE ONLY GETS A TEENY PART OF IT.
OH RIGHT. HOW CAN I FIGURE OUT IF I HAVE ENOUGH ENERGY?
KJ PER DAY ?
ALBERTA
YOU NEED TO FIND OUT HOW MANY JOULES OF ENERGY PER DAY ARE AVAILABLE AT YOUR PARTICULAR LOCATION. YOU CAN LOOK THAT UP. WATCH...

solar collector – a device that uses direct sunlight to heat a liquid which is circulated inside a building (an active solar device)

You receive 15 billion J per day per m^2 in southern Alberta. You make a **solar collector** 10 m × 5 m = 50 m^2 area. That's 50 × 15 billion J per day. You collect for three-quarters of the time the sun is up. Now it's 3/4 × 50 × 15 billion J. You are 1% efficient. 0.01 × 3/4 × 50 × 15 billion J. In one month you collect 30 × 0.01 × 3/4 × 50 × 15 billion. That's 225 billion J (225 gigajoules).


THAT'S A LOT! MY HIGHEST HEATING BILL LAST WINTER WAS FOR 35 GIGAJOULES OF ENERGY
NOT SO FAST! THE 15 BILLION JOULES/m² PER DAY IS A YEARLY AVERAGE. IT'S MUCH LOWER IN WINTER WHEN YOU NEED IT MOST
SO I'VE GOT MORE ENERGY THAN I NEED IN SUMMER AND NOT ENOUGH IN THE WINTER?
QUITE POSSIBLY. ALTHOUGH YOU MIGHT EVEN HAVE ENOUGH IN THE WINTER TOO: WHEN IT'S SUNNY. BUT WHO WANTS TO RISK IT AT -40°C? AND CAN YOU STORE THE EXTRA FROM SUMMER? NO.
AND MY WINDMILL?
SIMILAR STORY. YOU HAVE ENOUGH POWER SOMETIMES. STORING ELECTRICITY IS HARD. BOTH YOUR IDEAS WOULD HELP IF THEY WERE PART OF YOUR SYSTEM.
RIGHT! THEY WILL REDUCE MY BILLS WHEN THE SUN SHINES AND THE WIND BLOWS!

1. a. Why is Alberta **not** a good place to depend on a solar-heated house?

_____

_____

_____

b. What advantage is there to having a solar collector in Alberta?

_____

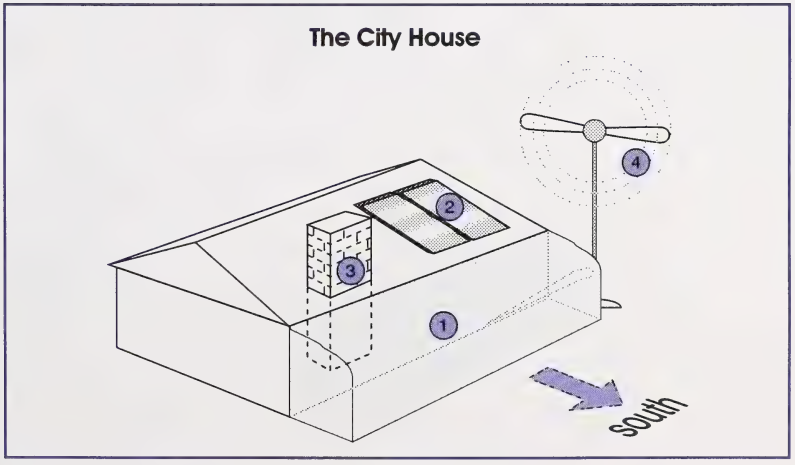
_____

_____

The amount of solar energy needed for one house, using a large solar collector, isn't that large. However, if you were to try to calculate the amount of solar energy needed to provide energy for a city, the amount is tremendous.

Solar collectors would need to be hundreds of thousands of times larger to provide energy for a city. The problem is that solar energy, although unlimited, is not very high-grade energy. Solar energy as a heating fuel makes good sense on a small scale and less sense on a large scale. It **can't** produce the energy needed to smelt ore or to make steel.

Look at the following houses. One is in a city, and one is on a farm. How can the various renewable energy sources be used to cut the amount of nonrenewable energy sources used in each case? You must answer the questions for one of the two houses.



passive solar device – a device which utilizes solar energy and lets natural convection move the heat

active solar device – a device which has moving parts or transports heat by moving liquids around mechanically

1. a sun room (**passive solar device**)
2. solar panels connected to hot water pipes (**active solar device**)
3. a large, massive, brick chimney and interior walls
4. a windmill generator

2. a. Why is there a massive brick wall near the sun room?

b. If the hot water pipes are connected from the hot water tank to the collectors, what effect will this have on a sunny day?

c. What is a major problem with using the solar collector panels in the winter?

d. How useful is the windmill?

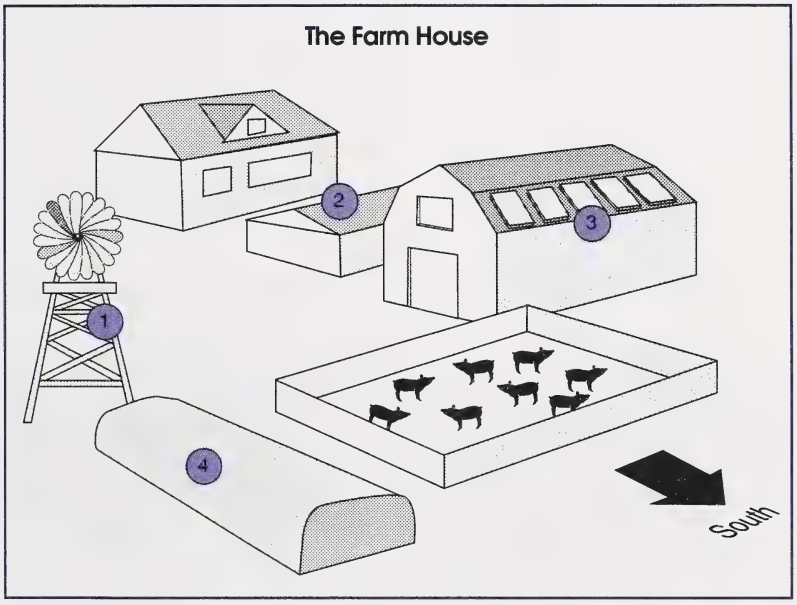
e. Something not drawn in the diagram is crucial to the system. It prevents heat from escaping. What is it?

_____

_____

_____

Check your answers by turning to the Appendix, Section 3: Activity 3.



1. windmill generator
2. greenhouse
3. solar panels connected to water or antifreeze pipes
4. methane digester

3. a. Why would a farm have a greenhouse?

b. Solar panels circulate cold liquid into the panels and hot liquid out of the panels. If the liquid was sent past hot water pipes, what effect would it have on the pipes?

c. How useful is the windmill? It is connected to a storage battery. (It keeps the battery charged up.)

methane digester – a device that breaks down manure to produce methane gas for fuel and sludge for fertilizer

d. A **methane digester** takes animal and human wastes and turns them into sludge and methane gas (natural gas). Why is it advantageous for a farm to have a methane digester?

Check your answers by turning to the Appendix, Section 3: Activity 3.

THE KEY TO USING RENEWABLE ENERGY SOURCES IS SMALL SCALE USE WHAT WORKS FOR YOUR SITE AND USE LESS ENERGY OVERALL
AND REMEMBER - WE STILL NEED FOSSIL FUELS TO MAKE THE HARDWARE THAT ALTERNATE ENERGY SYSTEMS NEED.

The following chart lists ways in which you can reduce energy consumption.

Reducing Energy Use	
Maintain the energy you already have.	• Insulate your house. • Caulk the windows. • Weatherstrip the doors. • Insulate the hot water heaters.
Reduce the amount of energy used.	• Use carpools. • Lower your thermostat. • Use energy-efficient appliances. • Turn lights off when not in use.
Change your lifestyle.	• Cycle to work or school. • Use public transportation. • Grow your own food. • Use recycled things whenever possible. • Compost your garbage – recycle the rest. • Don't use throwaway items.

Follow-up Activities

If you have some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Energy sources are renewable or nonrenewable. If you can replace a source used in one lifetime or less, then that source is renewable.

1. Indicate whether the following statements are true or false. If the statement is false, rewrite it to make it true.

   _____ a. Oil is a renewable resource.

   _____

   _____ b. Wood is a renewable resource.

   _____

   _____ c. Natural gas is a low-grade (not very concentrated) energy source.

   _____

   _____ d. Alberta has no major uranium deposits for nuclear energy.

   _____

   _____ e. Solar energy is nonrenewable.

   _____

In order to have energy, people must find it, get it out of the ground, convert it, deliver it to people, and clean up afterwards. Look at this chart:

Nuclear Energy	
find it	prospecting
extract it	build uranium mines purify the ore
deliver it	transport by truck, train, etc., to power stations
convert it	nuclear heat drives steam turbines to make electricity
clean up	store radioactive waste

2. Fill in the following chart.

Oil and Gas Energy	
find it	
extract it	
deliver it	
convert it	
clean up	

Check your answers by turning to the Appendix, Section 3: Extra Help.

Most renewable sources are cleaner than fossil fuels and don't run out as quickly. They aren't as high-grade though. Most renewable sources are different forms of solar energy. These sources work best for small-scale developments.

Alternative energy sources can be used to do the following things:

- heat water
- help heat a home
- provide some electricity
- fertilize gardens

If alternate energy sources are used to do these tasks, then the fossil fuels will last longer.

3. a. Name three things anyone could do to conserve energy.

_____

_____

_____

b. The fuel consumption of a car changes only a tiny bit when four people are in the car as compared to when one person is in it. In terms of energy conservation, how can you best use a car?

_____

_____

_____

c. If the temperature was – 40°C and the weather was sunny, how efficient would a solar house be?

_____

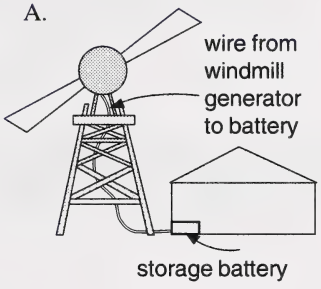
_____

_____

Energy is extremely hard to store. It's best used as it becomes available. Windmills produce electricity only when the wind is blowing.

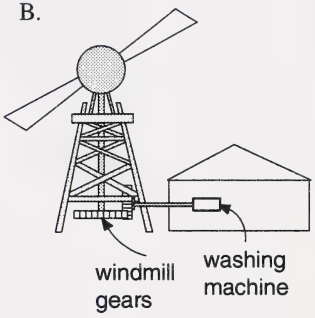
4. From the following two set-ups, pick the one that you think is best. Explain why you chose as you did.

A.



The windmill produces electricity and charges a battery.

B.



The windmill is geared to a clothes washer.

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

1. Build a model of a hydroelectric dam.
2. Research acid rain. Is Alberta in danger of being affected by acid rain?
3. Electric cars are relatively new. Research them and look for their advantages and disadvantages.
4. Look up methane digesters to find out how they work.

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you learned what renewable and nonrenewable energy sources are. You looked at nonrenewable use and possible alternative energy use of renewable sources. A combination of both plus an energy-conserving lifestyle is the best way to go.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

MODULE SUMMARY

Anything can be looked at as an energy system. The flow of energy through a system can be measured, and its efficiency can be calculated. Systems can then be improved upon and compared with other systems. Input energy must come from somewhere. There are both renewable and nonrenewable sources to choose from.

COURSE SURVEY FOR SCIENCE 24

Please evaluate this course and return this survey with your last module assignment. This is a course designed in a new distance-learning format, so we are interested in your responses. Your constructive comments will be greatly appreciated so that a future revision may incorporate any necessary improvements.

Name _____ Course _____

Address _____ Age ❑ under 19

_____ ❑ 19 to 40

_____ ❑ over 40

File No. _____ Date _____

Design

1. This course contains a series of Module Booklets and Assignment Booklets. Do you like the idea of separate booklets?

_____

_____

2. Have you ever enrolled in a correspondence course before that arrived as one large volume?

❑ Yes ❑ No If yes, which style do you prefer?

_____

_____

3. The Module Booklets contained a variety of self-assessed activities. Did you find it helpful to be able to check your work and have immediate feedback?

❑ Yes ❑ No If yes, explain.

_____

_____

4. Were the questions and directions easy to understand?

❑ Yes ❑ No If no, explain.

_____

_____

5. Each section contains Follow-up Activities. Which type of Follow-up Activity did you choose?

❑ mainly Extra Help
❑ a variety
❑ mainly Enrichment
❑ none

Did you find these activities beneficial?

❑ Yes ❑ No If no, explain.

_____

_____

6. Did you understand what was expected in the Assignment Booklets?

❑ Yes ❑ No If no, explain.

_____

_____

7. The course materials were designed to be completed by students working independently at a distance. Were you always aware of what you had to do?

❑ Yes ❑ No If no, provide details.

_____

_____

Name of Student _____ Student I.D. # _____

Name of School _____ Date _____

8. Suggestions for audiocassette and videocassette activities are included in the course. Were you able to use these media options?

❑ Yes ❑ No Comment on the lines below.

_____

_____

Course Content

1. What is your overall impression of the course? Did it meet your expectations?

_____

_____

2. Did you find the work load reasonable?

❑ Yes ❑ No If no, explain.

_____

_____

3. Did you have any difficulty with the reading level?

❑ Yes ❑ No Please comment.

_____

_____

4. How would you assess your general reading level?

❑ poor reader
❑ average reader
❑ good reader

Name of Student _____ Student I.D. # _____

Name of School _____ Date _____

5. Was the material presented clearly and with sufficient depth?

❑ Yes ❑ No If no, explain.

_____

_____

General

1. What did you like least about the course?

_____

_____

2. What did you like most about the course?

_____

_____

Additional Comments

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Name of Student _____ Student I.D. # _____

Name of School _____ Date _____

Only students enrolled with the Alberta Distance Learning Centre need to complete the remaining questions.

1. Did you contact Alberta Distance Learning Centre for help or information while doing your course?

   ❑ Yes ❑ No If yes, approximately how many times? _____

   Did you find the staff helpful?

   ❑ Yes ❑ No If no, explain.

   _____

   _____

2. Were you able to fax any of your assignments?

   ❑ Yes ❑ No If yes, comment on the value of being able to do this.

   _____

   _____

3. If you were mailing your assignments, how long was it taking for Assignment Booklets to return?

   _____

   _____

4. Was the feedback you received from your correspondence teacher helpful?

   ❑ Yes ❑ No Please comment.

   _____

   _____

   _____

   _____

Thanks for taking the time to complete this survey. Your feedback is important to us.

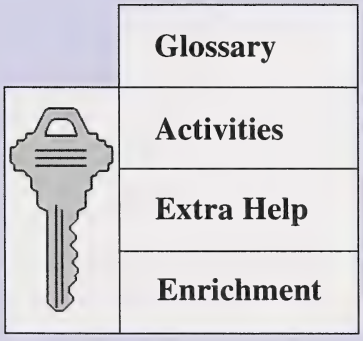
Fax Number: 674-6686

Instructional Design and Development Unit
Alberta Distance Learning Centre
Box 4000
Barrhead, Alberta
T0G 2P0

Name of Student _____ Student I.D. # _____

Name of School _____ Date _____

Appendix



Glossary

active solar device
- a device that moves the heat around mechanically

aerobic fitness
- a body's ability to convert food and oxygen into ATP as it enters the body's cell

ATP
- (adenosine triphosphate) a high-energy compound found in cells for storage and transfer of energy

conservation
- the principle that some part of a system is not changed after undergoing some event; it is conserved

efficiency
- the ratio of output energy to input energy expressed as a percent

energy conversion
- when one form of energy turns into another form of energy

energy efficient
- a system that has been designed to use less energy, or have a higher efficiency

energy input
- the energy put into a system to make it go

energy output
- the useful energy a system puts out

fossil fuels
- fuels from fossil remains of living things – coal, oil, natural gas

high-grade energy
- energy in a concentrated form

hydroelectric
- making electricity by using a waterfall to run a turbine

low-grade energy
- energy that is not in a concentrated form

methane digester
- a device that breaks manure down to produce methane gas for fuel and sludge for fertilizer

nonrenewable
- an energy source that can't be replaced in one lifetime

passive solar device
- a device that utilizes solar energy and lets natural convection move the heat

petrochemicals
- chemicals made from oil e.g., plastics

renewable
- an energy source that can be replaced in a lifetime or less

solar collector
- a device that uses solar energy to heat a liquid which is circulated into a building (an active solar device)

Suggested Answers

Section 1: Activity 1

1. input: food or chemical potential energy
   conversion: digestion, cellular respiration
   output: running or mechanical energy

2. carbon, oxygen, and hydrogen

3. input: solar energy, chemical energy from CO_2, H_2O
   conversion: a chemical reaction or rearranging the elements
   output: chemical potential energy in the glucose molecule

4. input: burning coal (chemical energy) turns to heat
   conversion: chemical energy from coal turns to heat to boil water
   output: steam – heat energy (and pressurized)

5. The water boils and steam escapes through the nozzles. A rocket effect makes the whole ball spin in the opposite direction as the escaping steam.

Section 1: Activity 2

1. a.

	Input	Output
cow	grass	milk, tissues, movement, etc.
person	carrot, steak	healthy body, energy to move

   Note: Inputs and outputs are relative to a particular organism.

   b. The sun is the original energy input.

2. input: gasoline (and battery)
   conversion: gas is burned to release heat energy
   output: mechanical energy (the car goes)

Section 1: Activity 3

1. a. Heat is lost to the air and in heating the beaker and stand.

   b. $\frac{29.2}{40} = \frac{n}{100}$ $\quad n = 73\%$

   The output energy is 73% of the input energy.

2. a. $\frac{\text{output}}{\text{input}} = \frac{500}{1000} \times 100 = 50\%$

   The machine has a 50% efficiency.

   b. You put in 200 000 000 J of energy (because $\frac{100}{200} = \frac{\text{output}}{\text{input}} = 50\%$).

Section 1: Follow-up Activities

Extra Help

1. a. input: water falls (gravitational energy)
   conversion: wheel (and axle) turns (gravity mechanical)
   output: saw cuts wood

   b. input: the sun (photosynthesis starts all food chains)
   conversions: plants convert solar energy to food (glucose)
   : bug converts plant to its body (protein)
   : fish converts bug protein
   output: fish health and motion

2. $\text{Efficiency} = \frac{\text{energy output}}{\text{energy input}} \times 100 = \frac{15\text{ J}}{60\text{ J}} \times 100 = 25\%$

   The efficiency of the system would be 25%.

3. $\text{Efficiency} = \frac{\text{work output}}{\text{work input}} \times 100 = \frac{400\ \text{J}}{500\ \text{J}} \times 100 = 80\%$

The efficiency would be 80%.

(If you have trouble remembering which number goes on top, remember that efficiency must be less than 100%).

Enrichment

1. Try contacting an engineer. Bicycle magazines are good too. Automobiles are about 20% efficient. Bicycles are more efficient.

2. The idea of perpetual motion can be seen in the prints of Maurits C. Escher. You may want to take a look at his prints.

Section 2: Activity 1

1. a. The mixture began to fizz or bubble.

   b. The weight (or mass) did not change much at all. (If you used the balance, it may seem heavier because you moved the position of the baking soda.)

2. a. Missing energy is heat produced by the body systems. This heat must be eliminated (e.g., sweating).
   Note: It takes 2268 kJ to evaporate 1 kg of water.

   b. The chicken's body produces heat too. Also the chicken's body takes a year to mature and it produces nonedible parts. Only 10% of the energy the chicken ate is used for its body parts.

   c. Some heat escapes into the air before it gets into the water. The steam spreads out taking its heat energy away from the wheel. Friction in the wheel causes it to heat up.

Section 2: Activity 2

1. a. low – You must feed the ox continually, and a plough loses energy to friction.

   b. high – The person uses about 1500 kJ of energy to ride the bicycle.

   c. low – It is 20% efficient.

   d. low – A plant converts about 4-7% of the light energy into glucose during photosynthesis.

2. If it took 3 min 45 s, then that is $3 \times 60 = 180 + 45 = 225$ seconds, so $2500 \times 225 = 563\,000$ J or 563 kJ.

3. a. For example, if your cold water was 21°C, you would take $98° - 21° = 77°$ for the change in temperature.

   b. Using the previous calculations as part of your data, this would be the calculation for useful energy output.

   Energy = 4.2 J/g°C × 77 °C × 500 g = about 162 000 J or 162 kJ

   c. Efficiency is $\frac{\text{output}}{\text{input}} = \frac{162\text{ J}}{563\text{ J}} \times 100 = 29\%$ using the previous calculations.

3. a.
   - Heat is lost to the air (stoves heat the kitchen too).
   - The element lights up a dull red (light doesn't heat water).
   - Water evaporates and carries heat into the air.
   - The stove heats the pot and itself too.

   b.
   - Cover the pot.
   - Put aluminum foil around the burner to reflect heat back to the pot.
   - Try a lighter pot (or a smaller one).

4. a. The longer run makes you use all the stored up chemical energy in your cells. A sprint just uses some of this chemical energy.

   b. The efficiency can be improved only by exercising. If you want your aerobic fitness to improve, you have to exert it. That means exercising until you are really out of breath, three times a week, for 15 min each time.

Section 2: Activity 3

1. a. The kettle is more efficient for boiling one litre of water. It does the job in a fraction of the time the microwave does, so it uses the least energy. (This takes into account the different wattage of the two devices.)

   b. The soybeans are the most energy efficient. Each stage of a food chain results in a loss of energy. Eating plants directly uses the least energy.

   c. Walking is the most energy efficient since it uses 16.2 kJ of energy per hour. Burning gasoline uses millions of joules of energy per litre.

   d. Hydroelectricity is the more efficient. Hydroelectric stations are about 90% efficient. Solar cells are only about 5-10% efficient.

2. Your answer will vary since it is only a prediction.

3. a. semitrailer – It's fairly fast and delivers close to or at a company's doorstep.

   b. plane – It's very fast. It's expensive, but sometimes speed is more important.

   c. train – It's the least expensive, but it takes longer and you have to go to the train station for the goods.

4. a. The train carries a great deal of freight at a time. It travels on level ground almost all of the time.

   b. It uses more energy to go faster than the train. It carries less freight at a time.

   c. Energy efficiency is sacrificed for speed. It takes a great deal of energy to lift a heavy load. Jumbo jets are better – they carry more.

Section 2: Follow-up Activities

Extra Help

1. • The gas is being burned at high temperature.
   • Friction between the moving parts of the engine produces heat.

2. a. You can only obtain 4-7% from food because that's the efficiency of photosynthesis.

   b. The percentage of the sun's energy transformed into your body is 10% of 7% (or 7/10 of 1%). Note: This is one step of the food chain.

   c. Ten percent of the answer for b. (or 7/100 of one percent) is transformed into body energy.

3. a. iii

   b. i

   c. ii

Enrichment

1. A powerful engine was developed soon after airplanes became commonplace. Efficient airplane design wasn't needed until things like the energy crisis of the 1970s.

2. Yes, you can get all your nutrients but you have to know how. Plants such as beans provide protein.

3. Research a shrew, a person, and a whale. Also try a small bird.

Section 3: Activity 1

1. a. windmills: renewable

   b. coal: nonrenewable

   c. solar: renewable

   d. nuclear: nonrenewable

   e. wood: renewable (if you're careful about replanting)

2. oil, natural gas , coal, nuclear power

3. Alberta will sell less energy but the deposits will last longer.

4. Alberta is too far from the equator to use an extensive amount of solar energy. Some windmills are working in southern Alberta. A few small hydroelectric stations exist. Alberta also depends on the biofuels.

Section 3: Activity 2

1. Positive aspects could include the following:
   - very concentrated, fuel goes a long way
   - a good substitute if no other sources are around
   - economically feasible

   Negative aspects could include the following:
   - radiation
   - waste } very hard to shield and store radioactive energy
   - used for nuclear weapons

2. Positive aspects could include the following:
   - easy to get
   - fairly concentrated energy
   - extremely versatile – makes hundreds of things
   - found here in Alberta

   Negative aspects could include the following:
   - many pollutants from burning (acid rain)
   - oil spills
   - greenhouse gases

3. a. Pipelines go to seaports (Vancouver, Prince Rupert), to Eastern Canada, and to the United States.

   b. It's more economic for oil companies to go find energy sources to get oil the hard way than to develop the new technologies for alternate energy sources. Note: It's easier for a large company to make money selling high-grade energy. Low-grade energy must be decentralized to be efficient.

   c. British Columbia is mountainous. Therefore, there is more water runoff in British Columbia. Alberta is mostly prairie or flatland.

   d. The coal-fired plants are located beside coal mining areas. This reduces transportation costs.

Section 3: Activity 3

1. a. The sun is very low in winter in Alberta. It might not keep the house warm.

   b. A solar collector will reduce energy costs. The gas furnace will come on less often.

Section 3: Activity 3

2. a. The brick heats up all day and helps keep the house warm at night. (It's a way to store heat for later.)

   b. The water in the collectors will get very hot so less gas is used by the hot water heater.

   c. Water pipes might freeze and burst. They will cool the water in the tank and cause more gas to be used by the hot water heater.

   d. Windmills will make electricity now and again. It's probably not worth the cost to build it.

   e. Insulation is crucial to an energy system. Note: This is the most inexpensive way to save energy.

3. a. A greenhouse could grow vegetables all year.

   b. The hot liquid would heat the hot water pipes. This lessens the load on the hot water heater.

   c. A windmill this size would be helpful to offset the cost of electricity.

   d. A farm has many animals contributing to the digester. A large amount of methane can be recovered. Sludge can go on crops as fertilizer.

Section 3: Follow-up Activities

Extra Help

1. a. False – Oil is not a renewable resource; there are only limited amounts of this fossil fuel.

   b. True – Wood can be renewable only if the trees are replanted.

   c. False – Natural gas is a high-grade energy source (higher than gasoline).

   d. True

   e. False – The sun will always provide an available source of energy.

2.

Oil and Gas Energy	
find it	oil exploration (check geology of rocks)
extract it	use oil platforms at sea or oil derricks pump oil out
deliver it	pipelines, tankers (ships), truck, train
convert it	refineries turn crude oil into gasoline, diesel, etc.
clean up	oil spills, gas well blowouts, acid rain, pipeline leaks, car exhausts

3. a. Some example answers are given:

   - turn appliances and lights off when not in use
   - ride a bide for short trips
   - car pool
   - keep car in good running shape
   - insulate your house well

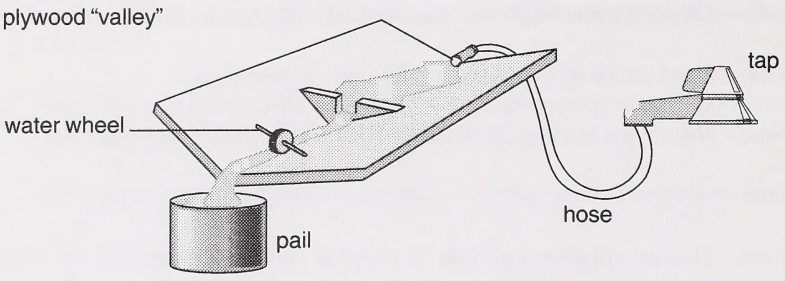
   b. Plan fewer trips and have more people in the car when making trips.

   c. A solar house is good. The sun will heat the house even at – 40°C provided it's well insulated. (How warm is the inside of a car parked outside in the sun at – 40°C?)

4. Choice A is the best set-up. You can use the battery anytime. When the wind blows, it gets charged (day or night).

Enrichment

1. Here are a few ideas:



2. Alberta is fairly protected against acid rain. It doesn't have the industrial emissions from burning coal or the industries that produce it as some heavily industrialized areas do.

3. Electric cars are designed for short trips, they need to have their batteries recharged, and they are less efficient then conventional cars. They are pollution-free and environmentally friendly.

4. Methane digesters are common to large urban waste-water treatment plants. Anaerobic bacteria decomposes solid waste into methane or biogas, carbon dioxide, and hydrogen sulfide (rotten egg gas). The same process is involved in rural farms where manure is decomposed. The gas is used as a fuel and the remaining sludge is spread on farmland as fertilizer.

N.L.C./B.N.C.
3 3286 50158 6883

L.R.D.C.
Producer

Science 24

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